

OSA-2185-6a
2 2



Westinghouse Electric Corporation

Air Arm Division

Friendship International Airport
Box 746, Baltimore 3, Md.
Telephone: 761-1000

November 13, 1962

Special Projects Office (ASZ-5)
Plans and Programs Office
Directorate of Production
Wright-Patterson AFB, Ohio

A 102-403

SUBJECT: Contract AF 33(600)-40280, Reduction
in Scope, Motion Compensation.
Westinghouse Ref. AAW-45196-20

Reference (a): Westinghouse Letter dated 27 August 1962, subject:
Contract AF 33(600)-40280, Program Extension.

Enclosure (1): Three (3) copies Westinghouse Specification R-1916, Rev.
A dated November 7, 1962 entitled "Antenna Angle and Motion
Compensation, Follower Version".

Enclosure (2): Three (3) copies Westinghouse Cost and Price Analysis,
Form FE-777-1 dated November 12, 1962.

Gentlemen:

The proposal submitted by Reference (a) and which subsequently
was incorporated in the Contract by Amendment No. 13, included design and
fabrication effort necessary to achieve motion compensation by roll stabi-
lizing the linear cross track accelerometers and by stabilizing the
antennas for two systems with a total estimated cost of \$ 142,283. (Refer
to Item I, Section B of Reference (a)). Recent technical discussions
have indicated the desirability of your directly procuring the signal
sources, servos and actuators required for such motion compensation in
accordance with a performance specification to be furnished by Westinghouse.
Under this approach Westinghouse proposes to provide:

- (a) System design integration including the preparation
of motion compensation performance specifications.
- (b) Liaison and design follow to assure overall system
compatibility.
- (c) A mechanical preliminary design study for antenna angle
control and design of servo installation on the radar frame.

25 YEAR RE-REVIEW

Attn: ASZ-5

-2-

November 13, 1962

The effort quoted for breadboard antenna stabilization and its evaluation quoted under Item 5, Section B, Flight Test, of Reference (a) is not affected by this proposal.

The performance specification has been developed based on several conferences with interested parties and is forwarded as Enclosure (1) for your review and consideration.

Our quotation for performing the effort outlined above is \$36,006 total estimated cost, and \$ 2,520 fixed fee. Enclosure (1) is an analysis of this quotation. Since this effort would replace that quoted under Item 1, Section B of Reference (a) for \$ 142,283 total estimated cost, the net reduction in total Contract Cost would be \$106,277.

Based on the fee negotiated for the SOARD Extension, the prorated fee for the \$142,283 total cost being deleted is \$ 8,878; therefore the net reduction in fee would be this figure less \$2,520 or \$ 6,358.

Technical coordination with interested groups is continuing pending your decision as to source for the motion compensation hardware. We have for the moment held work on its detailed design and fabrication as authorized by Amendment No. 13. If you adopt the proposal outlined herein, we will be glad to discuss the contractual arrangements at your convenience. However, because we are currently holding up authorized work which you may later procure elsewhere, an early decision on this proposal is desirable.

Very truly yours,
WESTINGHOUSE ELECTRIC CORPORATION

STAT

[Redacted]
Project Liaison
Marketing Department

RWE:sf
Enc.

FORM AAE-54A



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

ANTENNA ANGLE AND MOTION COMPENSATION

(FOLLOWER VERSION)

A	11-7-62		3,4,5,6		
REV. LETTER	DATE	CHANGE ORDER NO.	PAGES AFFECTED	BY	APPROVED
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APPROVED		APPROVED			
SHEET 1 OF 2 SHEETS		DATE 11-7-62	TOP DWG	SPEC. NO.	R-1916

The purpose of this specification is to describe the functional units necessary to achieve compensation for aircraft motion. Section 1.0 includes the roll stabilized platform and related electronics to achieve compensated cross track acceleration of no more than 2 mill g or 1/16 wavelength, whichever is the more severe limitation at a particular frequency of disturbance. Section 2.0 includes the electronics for antenna positioning in the yaw axis to maintain the beam center within 2 milliradians of the intended pointing direction independently of aircraft motion in pitch and yaw. The environmental limitations are also included.

1.0 CROSS TRACK VELOCITY COMPENSATION

See Figure 1

1.1 Roll Stabilized Platform

1.1.1 Outline limitation	Figure 2
1.1.2 Roll axis alignment to aircraft	1°
1.1.3 Accelerometer positioning relative to line of sight.	1 ft.
1.1.4 Accelerometer depression in roll	29° \pm 1°
1.1.5 Maximum roll rate	10°/sec.
1.1.6 Maximum roll acceleration	50°/sec ²
1.1.7 Positioning accuracy	.1 milliradian
1.1.8 Operating temperature range	-100°F to 300°F
1.1.9 Maximum temperature range	-54°F to +300°F
1.1.10 Unattended service life	1000 hrs.

1.2 Integrator and Network

1.2.1 Maximum velocity	50 ft/sec
1.2.2 Velocity resolution	.01 ft/sec
1.2.3 Linearity	1%
1.2.4 Idealized network response	



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 3

SPEC.
NO.

R-1516

REV
A

$$F(s) = \frac{2\tau_1 s (1 + 1/2 \tau_1 s)}{(1 + \tau_1 s)^2} \times \frac{(1 + 3\tau_2 s)}{(1 + \tau_2 s)^3}$$

$$\tau_1 = 63.3 \text{ sec}$$

$$\tau_2 = .0106 \text{ sec}$$

1.2.5	Operating temperature range	+80° to +120°F
	Maximum temperature range	-55° to 120°F
1.3	Frequency Off-Set Generator	
1.3.1	Frequency range	+200 cps to 600 cps
1.3.2	Linear voltage range	+2.5 volt to -2.5v
1.3.3	Frequency resolution	.2 ft/sec
1.3.4	Linearity	1/2
1.3.5	Frequency sensitivity	330 cps/volt
1.3.6	Input impedance	50k ohms
1.3.7	Operating temperature range	+80° to +120°F
1.3.8	Maximum temperature	-54° to +120°F
1.4	Accelerometer	
1.4.1	Maximum acceleration	1 G
1.4.2	Resolution	1 milli G
1.4.3	Linearity	1/2
1.4.4	Upper frequency limit	20 cps
1.4.5	Operating temperature range	100° to 300°F
1.4.6	Maximum temperature range	-54° to 300°F



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 4

SPEC. NO.

R-1516

REV A

FORM AAE-59A

2.0 ANGLE COMPENSATION

Figure 1

- 2.1 Open loop antenna pointing error overall $\pm 3^\circ$ (30°)
- 2.2 Antenna open loop response to aircraft motion 4 cps
- 2.3 Antenna system sensitivity at the input to the antenna follow serv. 1 degree/volt
- 2.4 Summing point shall be capable of accepting a signal from the doppler tracker (output impedance < 500 Ω) and summing it with the open loop commands with unity gain.
- * 2.5 Operating temperature range. -80° to $+120^\circ$ F
- 2.7 Maximum temperature range -54° to $+140^\circ$ F
- 2.8 Position potentiometer
 - 2.8.1 Operating temperature range 100° F to 450° F
- * 2.5 The doppler frequency tracker will close the antenna pointing loop at low frequencies with a gain in excess of 5 volt/deg and with unity gain at 1/10 cps.



Westinghouse ELECTRIC CORPORATION

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 5

SPEC. NO.

R-1916

REV

FORM AAE-55A

3.0 GENERAL

- 3.1 The environmental conditions except temperature and detailed in R-1811.
- 3.2 In the event of conflict between this document and any MIL Specification this document shall govern.



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 6

SPEC. NO. R-1916

REV
A

MOTION COMPENSATION by angle reference

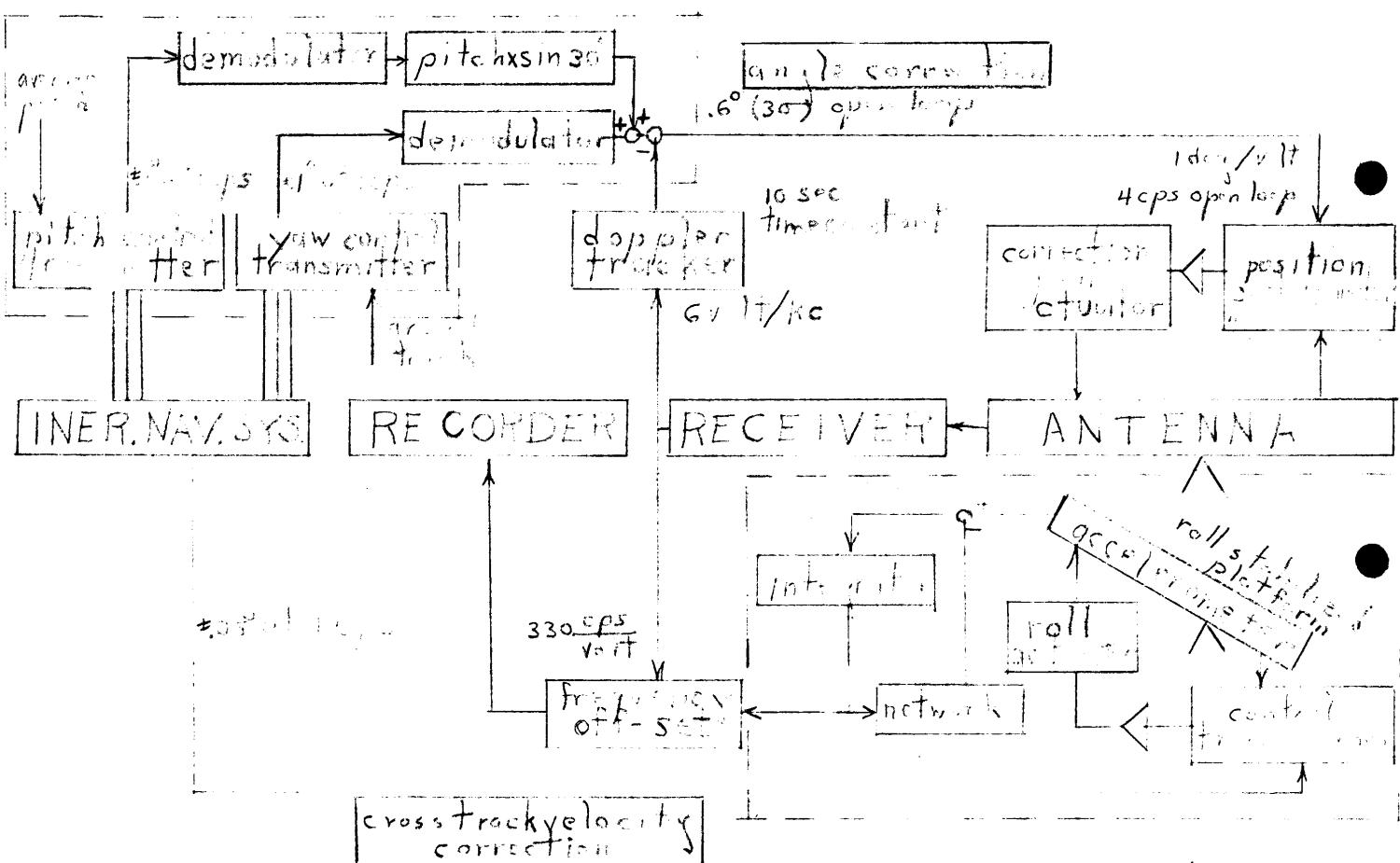


Fig 1 25X1

10/18/62

FORM AAE-53A

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A. J. S. 13

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Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION BALTIMORE MD. U.S.A.

SHEET 8

SPEC.
NO. R-1216

NAME OF CONTRACTOR

Westinghouse Electric Corporation - Air Arm Division

Enc 12)

ADDRESS (STREET)

P.O. Box 746

CITY

Baltimore

ZONE

3

STATE

Maryland

ORDER OR FILE NO.

AAN-45196-20

PRIME SUB

PURCHASE REQUISITION NO.

CONTRACT NO.

AF33(600)-40280

ITEM NO.

All

ARTICLE

Motion Compensation System Investigation, Follow

TERMS AND DISCOUNT

and Mech. Study

ANALYSIS OF PRICE AS OF

November 12, 1962

TYPE OF CONTRACT

CPFF

QUANTITY

AT

S

AMOUNT

38,526

EACH \$

NET TOTAL OF CONTRACT

S

INDICATE WHETHER DATA BELOW IS:

PER UNIT OR TOTAL

LINE

ITEM

AMOUNT

1. MANUFACTURING COST - DIRECT:		XXXXXX	XXXXXX
A. DIRECT MATERIAL			XXXXXX
B. FACTORY LABOR (HOURS)			XXXXXX
C. FACTORY OVERHEAD			XXXXXX
D. TOOLS, DIES, JIGS, PATTERNS & FIXTURES			XXXXXX
E. OTHER (SCHEDULE ATTACHED)			XXXXXX
F. TOTAL DIRECT MANUFACTURING COST		XXXXXX	XXXXXX
2. PRODUCT DEVELOPMENT (% OF 1F)		XXXXXX	
3. ENGINEERING COST - DIRECT:		XXXXXX	
A. DIRECT MATERIAL			XXXXXX
B. ENGINEERING LABOR (3,055 HOURS)		\$ 15,020	XXXXXX
C. ENGINEERING OVERHEAD		12,289	XXXXXX
D. OTHER (SCHEDULE ATTACHED)	Travel	4,535	XXXXXX
E. TOTAL DIRECT ENGINEERING COST			XXXXXX
4. GENERAL RESEARCH (4.5 % OF 1F + 2 + 3E)			\$ 31,844
5. TOTAL MANUFACTURING & ENGINEERING COST (1F + 2 + 3E + 4)			1,433
6. GENERAL AND ADMINISTRATIVE EXPENSE (8.2 % OF 5)			33,277
7. CONTINGENCIES (FURNISH DETAILS)			2,729
8. OTHER EXPENSES (FURNISH DETAILS)			
9.			
10.			
11. TOTAL COST (SUM OF LINES 5 THRU 10)			36,006
12.			
13. OPERATING PROFIT OR FIXED FEE			2,520
14.			
15.			
16. TOTAL ESTIMATED COST INCLUDING FIXED FEE - COST TYPE CONTRACTS			
17. SELLING PRICE - FIXED PRICE CONTRACTS			\$ 38,526
18.			
19.			
20.			

SEE DESCRIPTION OF COST AND PRICE ANALYSIS PROCEDURE

The subcontracted portion of this contract is estimated at

% of selling price.

CERTIFICATION

This is to certify that the above information contained in this report has been compiled from the records and books of this company (or is an estimate based on such books and records) and to the best of our knowledge and belief the costs and expenses shown hereon are correctly stated.

STAT

Westinghouse Electric Corp. - Air Arm Div.

CONTRACTOR

November 13, 1962

DATE

ing Department

STAT

Enclosure (1)

Manager, Accounting Department

AAN-45196-20 - 13 November 1962

1962

	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor and Overhead Dollars</u>
Support & Evaluation	1,400	\$ 4.99	3.82	\$ 12,334
Mach. Design & Development	795	5.10	3.71	7,004

NOTE: Engineering Labor Adjustment of 0.9% to be applied to above rates.

1963

	<u>Manhours</u>	<u>Labor Rate</u>	<u>Overhead Rate</u>	<u>Labor & Overhead Dollars</u>
Support & Evaluation	600	\$ 4.99	43.82	\$ 5,286
Mach. Design & Development	260	5.10	3.71	2,291

NOTE: Engineering Labor Adjustment of 2.9% to be applied to above rates.

Westinghouse Electric Corporation - Air Arm Division

ADDRESS (STREET)

P.O. Box 746

CITY	ZONE	STATE	ORDER OR FILE NO.	PRIME <input checked="" type="checkbox"/> SUB <input type="checkbox"/>		PURCHASE REQUISITION NO.
				AT	AMOUNT	
Baltimore	3	Maryland	AAE-45196-20	\$/ EACH	\$ 38,526	AF33(600)-40280 All

ARTICLE
Motion Compensation System Investigation, Follow

TERMS AND DISCOUNT

and Mech. Study

ANALYSIS OF PRICE AS OF	TYPE OF CONTRACT	INDICATE WHETHER DATA BELOW IS:	
		PER UNIT <input type="checkbox"/>	OR TOTAL <input checked="" type="checkbox"/>
November 12, 1962	C377		

LINE	ITEM	AMOUNT
1. MANUFACTURING COST - DIRECT:		
A. DIRECT MATERIAL		X X X X X
B. FACTORY LABOR (HOURS)		X X X X X
C. FACTORY OVERHEAD		X X X X X
D. TOOLS, DIES, JIGS, PATTERNS & FIXTURES		X X X X X
E. OTHER (SCHEDULE ATTACHED)		X X X X X
F. TOTAL DIRECT MANUFACTURING COST		X X X X X
2. PRODUCT DEVELOPMENT (% OF 1F)		X X X X X
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Westinghouse Electric Corp. - Air Arm Div.

November 13, 1962

Enclosure

SIGNATURE AND TITLE

STAT

- Manager, Marketing Department

SIGNATURE AND TITLE

- Manager, Accounting Department

AAE-45196-20 - 13 November 1962

1962

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end (1)

FORM AAE-54A



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

ANTENNA ANGLE AND MOTION COMPENSATION
(FOLLOWER VERSION)

A	11-7-62	3,4,5,6			
REV. LETTER	DATE	CHANGE ORDER NO.	PAGES AFFECTED	BY	APPROVED
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APPROVED			APPROVED		
SHEET 1 OF 8 SHEETS		DATE 11-7-62	TOP DWG	SPEC. NO.	R-1916

The purpose of this specification is to describe the functional units necessary to achieve compensation for aircraft motion. Section 1.0 includes the roll stabilized platform and related electronics to achieve compensated cross track acceleration of no more than 2 mill g or 1/16 wavelength, whichever is the more severe limitation at a particular frequency of disturbance. Section 2.0 includes the electronics for antenna positioning in the yaw axis to maintain the beam center within 2 milliradians of the intended pointing direction independently of aircraft motion in pitch and yaw. The environmental limitations are also included.

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See Figure 1

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1.1.6 Maximum roll acceleration	50°/sec ²
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1.1.8 Operating temperature range	-100°F to 300°F
1.1.9 Maximum temperature range	-54°F to +300°F
1.1.10 Unattended service life	1000 hrs.

1.2 Integrator and Network

1.2.1 Maximum velocity	50 ft/sec
1.2.2 Velocity resolution	.01 ft/sec
1.2.3 Linearity	1%
1.2.4 Idealized network response	



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 3

SPEC. NO. R-1916

REV. A

$$F(s) = \frac{2 \tau_1 s (1 + 1/2 \tau_1 s)}{(1 + \tau_1 s)^2} \times \frac{(1 + 3 \tau_2 s)}{(1 + \tau_2 s)^3}$$

$$\tau_1 = 63.8 \text{ sec}$$

$$\tau_2 = .0106 \text{ sec}$$

1.2.5	Operating temperature range	+30° to +120°F
	Maximum temperature range	-55° to 120°F
1.3	Frequency Off-Set Generator	
1.3.1	Frequency range	+200 cps to 600 cps
1.3.2	Linear voltage range	+2.5 volt to -2.5v
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1.3.4	Linearity	1/3
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1.3.6	Input impedance	50k ohms
1.3.7	Operating temperature range	+30° to +120°F
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1.4	Accelerometer	
1.4.1	Maximum acceleration	1 G
1.4.2	Resolution	1 milli G
1.4.3	Linearity	1/3
1.4.4	Upper frequency limit	20 cps
1.4.5	Operating temperature range	100° to 300°F
1.4.6	Maximum temperature range	-54° to 300°F



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 4

SPEC.
NO.

R-1-16

REV
A

2.0 ANGLE COMPENSATION

2.1 Open loop antenna pointing error overall Figure 1
±.6° (30°)

2.2 Antenna open loop response to aircraft motion 4 cps

2.3 Antenna system sensitivity at the input to the antenna follow serv. 1 degree/volt

2.4 Summing point shall be capable of accepting a signal from the doppler tracker (output impedance < 500 Ω) and summing it with the open loop commands with unity gain. *

2.5 Operating temperature range. +80° +120°F

2.6 Maximum temperature range -54° +140°F

2.8 Position potentiometer

2.8.1 Operating temperature range 100°F to 450°F

* 2.5 The doppler frequency tracker will close the antenna pointing loop at low frequencies with a gain in excess of 1 volt/deg and with unity gain at 1/10 cps.



Westinghouse ELECTRIC CORPORATION

AIR ARM DIVISION

BALTIMORE MD. U.S.A.

SHEET 5

SPEC. NO.

R-1,16

REV

A

FORM AAE-55A

3.0 GENERAL

- 3.1 The environmental conditions except temperature and detailed in R-1811.
- 3.2 In the event of conflict between this document and any MIL Specification this document shall govern.



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 6

SPEC.
NO. R-1916

REV
A

FORM AAE-85A

12.0

3.0

* CRAFTING DIMENSIONS

AXIS OF
ACCF.

69°



Westinghouse ELECTRIC CORPORATION
AIR ARM DIVISION
BALTIMORE MD. U.S.A.

SHEET 8

SPEC.
NO.

R-1916

REV

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SPECIFICATION PAGE	REVISION INDEX	PAGE NO.	SPEC. NO.	R	REV.
FORM AAE-59		2	R-1916		

MOTION COMPENSATION

by angle reference

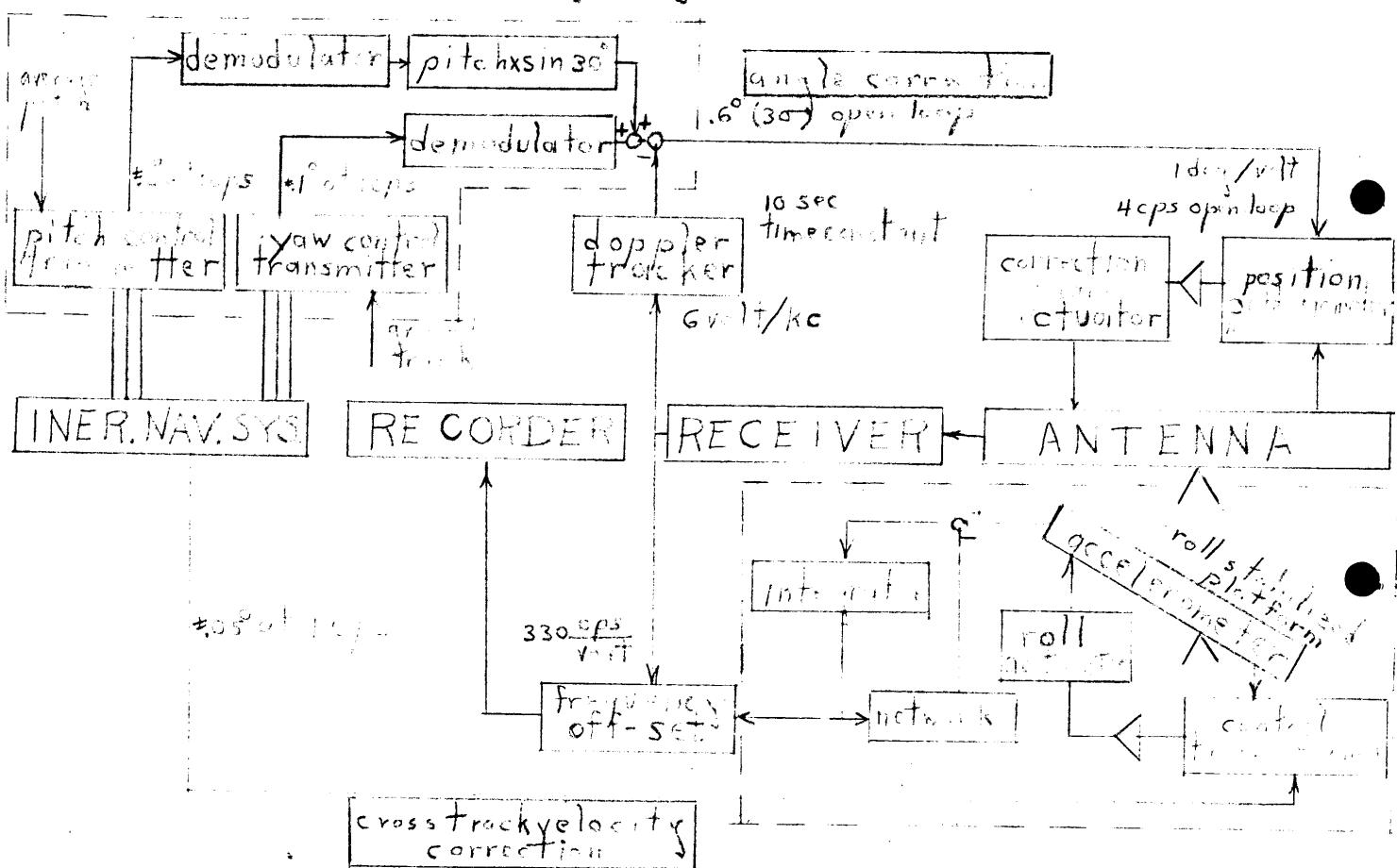


Fig. 1

10/18/62
M. S. White et al.